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ABSTRACT

The summary information contained in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Mathematics 30 Diploma Examination by the Alberta Department of Education in Canada. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. Findings indicate that 88.2% of the 9,470 students who took the test achieved the acceptable standard and 20.6% of these students achieved the standard of excellence. Topics discussed include a description of the examination, achievement of standards, results and examiners' comments, multiple-choice and numerical-response questions, students' achievement of the curriculum standards in the units on permutations and combinations and exponential and logarithmic functions, written-response questions, and a scoring guide for written-response questions. (JRH)

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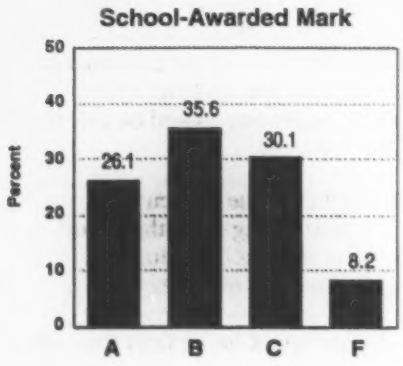
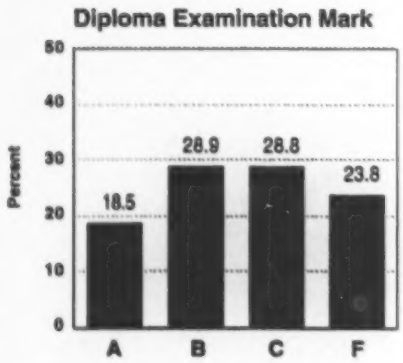
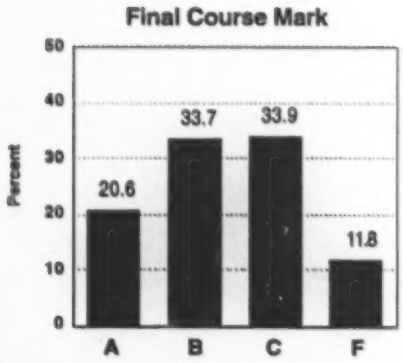
Mathematics 30

Diploma Examination Results
Examiners' Report for January 1997







The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Mathematics 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made availabe annually.

Description of the Examination

The Mathematics 30 Diploma Examination consists of 40 multiple-choice questions worth 57.1%, 9 numerical-response questions worth 12.9%, and 3 written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 9 470 students who wrote the January 1997 examination.

- 88.2% of the 9 470 students achieved the acceptable standard (a final course mark of 50% or higher).
- 20.6% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50% of the students who wrote the January 1997 examination were females.

- 87.2% of the female population achieved the acceptable standard (a final course mark of 50% or higher).
- 18.8% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50% of the students who wrote the January 1997 examination were males.

- 89.3% of the male population achieved the acceptable standard (a final course mark of 50% or higher).
- 22.4% of these students achieved the standard of excellence (a final course mark of 80% or higher).

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Student Evaluation

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Provincial Averages

- The average school-awarded mark was 68.8%.
- The average diploma examination mark was 62.5%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 66.0%.

Of the 9 470 students who wrote the January 1997 examination, 1 313 had written at least one Math 30 exam previously.

Results and Examiners' Comments

This examination has a balance of question types and difficulties reflecting the philosophy of the Mathematics 30 Course of Studies. It was designed so that students who are achieving the acceptable standard in Mathematics 30 should obtain a mark of 50% or higher. Students who are achieving the standard of excellence in Mathematics 30 should obtain a mark of 80% or higher. Students who are achieving the acceptable standard or the standard of excellence are expected to be able to achieve the curriculum standards identified in the *Mathematics 30 Information Bulletin, Diploma Examination Program*. At least 70% of the examination includes questions and tasks that students who achieve the acceptable standard should be able to complete successfully. The remaining part of the examination includes questions and tasks that students who achieve the standard of excellence should be able to complete successfully.

Future examinations will continue to focus on assessing students' understanding of mathematical concepts and on problem solving. Students will continue to be expected to solve problems and explain, justify, or prove solutions in the written-response section. The design of future field tests and examinations will include items that assess how well students have achieved the general learner expectations stated in the Mathematics 30 Course of Studies.

Blueprint

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC 1	D	0.786	√							C
MC 2	B	0.805	√							P
MC 3	D	0.562	√							PS
MC 4	A	0.825	√							P
MC 5	D	0.482	√							PS
MC 6	C	0.720	√							C
MC 7	C	0.384	√							PS
MC 8	B	0.804		√						P
MC 9	A	0.717		√						PS
MC 10	C	0.697		√						C
MC 11	A	0.543		√						PS
MC 12	D	0.740		√						P
MC 13	C	0.410		√						C
MC 14	A	0.576					√			C
MC 15	B	0.474					√			P
MC 16	D	0.732					√			P
MC 17	A	0.812					√			P
MC 18	D	0.569					√			C
MC 19	A	0.768					√			P
MC 20	C	0.731					√			PS
MC 21	D	0.648				√				C
MC 22	D	0.797				√				C
MC 23	A	0.729				√				C
MC 24	B	0.666				√				C
MC 25	B	0.854				√				P
MC 26	B	0.369				√				PS
MC 27	C	0.884							√	C
MC 28	D	0.884							√	C
MC 29	D	0.648							√	P
MC 30	B	0.643							√	PS
MC 31	B	0.524							√	PS
MC 32	A	0.355							√	PS

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Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC 33	A	0.760						√		PS
MC 34	A	0.567						√		P
MC 35	C	0.639						√		PS
MC 36	C	0.672						√		P
MC 37	B	0.812						√		P
MC 38	D	0.744			√					P
MC 39	C	0.867			√					P
MC 40	A	0.689			√					C
NR 1	102	0.833	√							P
NR 2	95.5	0.523		√						P
NR 3	0.38	0.647		√						P
NR 4	0.5	0.669					√			P
NR 5	8.2	0.454							√	C
NR 6	47.6	0.706				√				P
NR 7	126	0.360						√		PS
NR 8	260	0.809						√		P
NR 9	0.88	0.733			√					P
WR 1	–									PCPS
WR 2	–									PCPS
WR 3	–									PCPS

Subtests

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 32.6 out of 49

Written response: 7.9 out of 15

Course Content (Machine Scored)

Poly. Fn.	Polynomial Functions	5.4 out of 8
Trig. Fn.	Trigonometric and Circular Functions	5.1 out of 8
Stat.	Statistics	3.0 out of 4
Quad. Rltns.	Quadratic Relations	4.5 out of 7
Exp. & Log.	Exponential and Logarithmic Functions	5.3 out of 8
Perm. & Com.	Permutations and Combinations	4.6 out of 7
Seq. & Series	Sequences and Series	4.6 out of 7

Mathematical Understandings*

- Procedural (P): 16 out of 22
- Conceptual (C): 9.5 out of 14
- Problem Solving (PS): 7.1 out of 13

*Refer to Appendix D of the 1995–96 *Mathematics 30 Information Bulletin, Diploma Examinations Program,* for an explanation of mathematical understandings. These are the mathematical abilities described in Appendix G.

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33. There are 4 different video cassettes and their 4 corresponding video cases lying on the floor. A young child who cannot read randomly puts a video in each case. What is the probability the child put the correct video in each box?

*A. $\frac{1}{4!}$

B. $\frac{2}{4!}$

C. $\frac{1}{8!}$

D. $\frac{4!}{8!}$

B A candy vending machine has a button for each of the 26 letters of the alphabet and for each digit, 0 to 9. To buy a certain type of candy, you must enter a letter followed by a number. The **maximum** number of different types of candy that this vending machine could dispense is _____.
(Record your answer on the answer sheet.)

Answer: **260**

Multiple-Choice and Numerical-Response Questions

The multiple-choice and numerical-response sections of the examination comprise questions that sample all content areas in Mathematics 30. A discussion of students' achievement of the curriculum standards in the units Permutations and Combinations, and Exponential and Logarithmic Functions follows.

Permutations and Combinations — In order to achieve the curriculum standards for this unit, students should be able to calculate the number of linear, circle, and ring permutations, calculate the number of permutations with repetitions of n things taken r at a time, and be able to calculate the number of combinations of n things taken r at a time. In addition, students should be able to expand binomials of the form $(x + a)^n$, $n \in W$, using the Binomial Theorem and be able to describe, orally and in writing, the difference between a permutation and a combination. Students are expected to be able to participate in and

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15. The graphs of $y = \log_3(x - 1) + 1$ and of $y = \log_3(2x + 1)$ intersect at a point. An equation that could be used to find this point of intersection is

A. $\log_3[(2x + 1)(x - 1)] = 1$

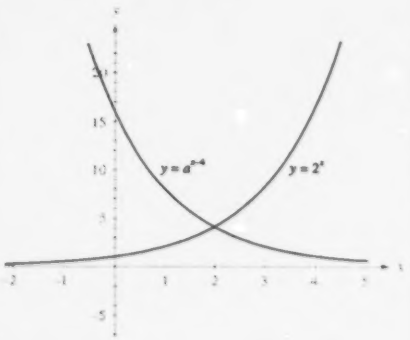
•B. $\log_3 \dfrac{(2x + 1)}{(x - 1)} = 1$

C. $\log_3(2x + 1) \log_3(x - 1) = 1$

D. $\dfrac{\log_3(2x + 1)}{\log_3(x - 1)} = 1$

Use the following information to answer the next question.

The graphs of $y = 2^x$ and $y = a^{x-4}$ intersect when $x = 2$, as shown below.



4. Given that a is a positive number, the value of a, correct to the nearest tenth, is _____. (Record your answer on the answer sheet.)

Answer: **0.5**

contribute toward the problem-solving process for problems involving permutations and/or combinations, including probability problems studied in Mathematics 30.

Multiple-choice questions 33 to 37 and numerical-response questions 7 and 8 required students to demonstrate their understanding of this unit. The percentage of students who achieved the acceptable standard but not the standard of excellence and answered multiple-choice questions 33 to 37 correctly varied from 35.9% for question 37 to 86.2% for question 36, with 57.6%, 64.9%, and 68.3% answering questions 33, 34, and 35, respectively. These multiple-choice questions and numerical-response question 8 identified expectations for those students who achieved the acceptable standard but not the standard of excellence; over 68% of students who achieved the acceptable standard on the examination were able to successfully achieve the expectations of these questions.

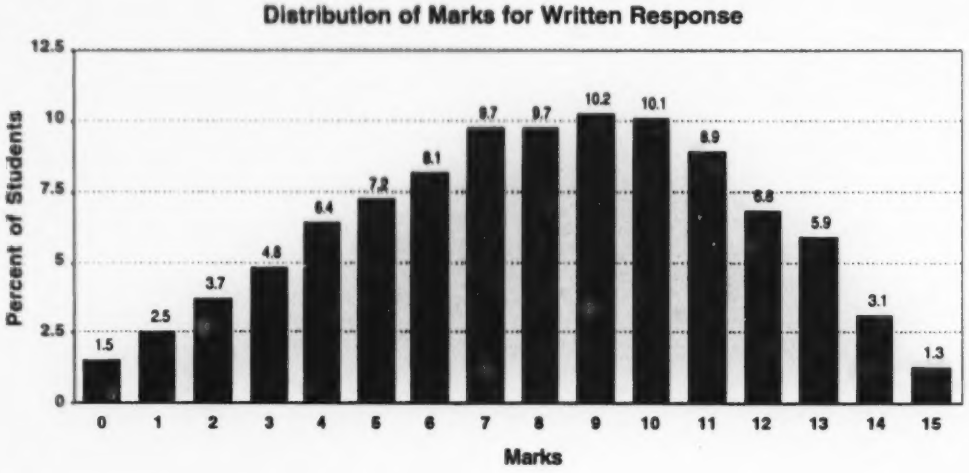
Students who achieve the standard of excellence are also expected to be able to explain the reason that there are different numbers of permutations when a given number of objects are arranged in a line, a circle, or a ring, or when some of the objects are repeated or are identical. In addition, these students are able to determine specific terms of the expansion of binomials of the form $(x + by)^n$, $n \in W$, using the binomial theorem. Achievement of the standard of excellence also requires that students complete the solution to problems that can be represented by permutations and combinations studied in Mathematics 30. Numerical-response question 7 required students to show that they can do this. Of the students who achieved the standard of excellence on the examination, 70% answered this question correctly.

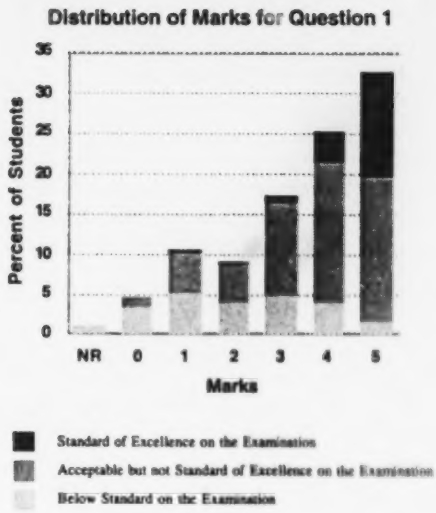
Exponential and Logarithmic Functions — To achieve the acceptable standard in exponential and logarithmic functions, students must be able to generate the graph of exponential and logarithmic functions with the use of graphing calculators or graphing utility packages, recognize and sketch the graphs of exponential and logarithmic functions and recognize their inverse relationship, convert functions from exponential form to logarithmic form and vice versa, and be able to apply the laws and properties of logarithms to evaluate logarithmic expressions. They must also be able to solve and verify simple exponential and logarithmic equations, state the domain and range of the exponential and logarithmic functions, and use the graphs of the exponential and logarithmic functions to estimate the value of one of the variables, given the other variable. In addition, these students should be able to participate in and contribute toward the problem-solving process from problems that can be represented by logarithmic or exponential functions studied in Mathematics 30.

Multiple-choice questions 14 to 20 and numerical-response question 4 required students to demonstrate their understanding of this unit. The percentage of students who achieved the acceptable standard but not the standard of excellence and answered multiple-choice questions 14 to 20 correctly varied from 47.1% for question 15 to 86.0% for question 17, with 59.4%, 78.2%, 56.0%, 80.0%, and 76.3% answering questions 14, 16, 18, 19, and 20, respectively and 71.3% correctly answered numerical-response question 4. In addition to the expectations for the acceptable standard, students who achieve the standard of excellence must also be able to solve and verify exponential and logarithmic equations and complete the solution to problems that require the analysis of exponential and logarithmic functions studied in Mathematics 30. Multiple-choice question 20 required this of students. Of the students who achieved the standard of excellence, 96.6% answered question 20 correctly.

Written-Response Questions

As published in the 1995–96 and 1996–97 *Mathematics 30, Diploma Examination Information Bulletins*, the written-response questions assess whether or not students can draw on their mathematical experiences to solve problems and to explain mathematical concepts. Therefore, the written-response questions do not necessarily fall into a particular unit of study but may cross more than one unit or may require students to make connections among mathematical concepts. Students achieving the acceptable standard are expected to obtain at least half marks on all questions. Students achieving the standard of excellence are expected to answer all questions almost perfectly.

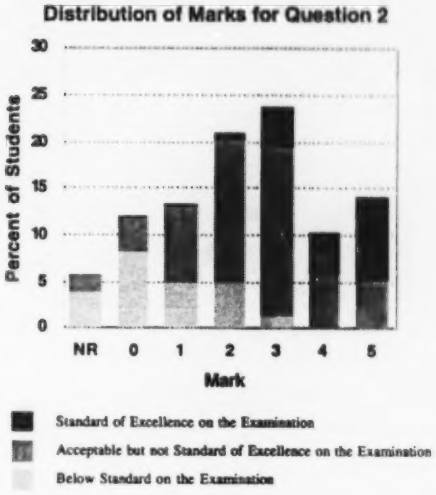




Question 1 required students to correctly determine the space required for 3 "nested" shopping carts, using the given information. They were also asked to determine an expression for *n* carts and to calculate how many nested carts would have a length 10.0 m. Finally, they were asked to decide between two storage shed designs and support their conclusion.

It was expected that students achieving the acceptable standard of achievement would score 3 out of 5 marks. Of the students who met the acceptable standard of achievement on the examination, 85% received at least 3 out of 5 marks, and of students who achieved the standard of excellence on the examination, 92.8% scored 4 or more marks out of 5.

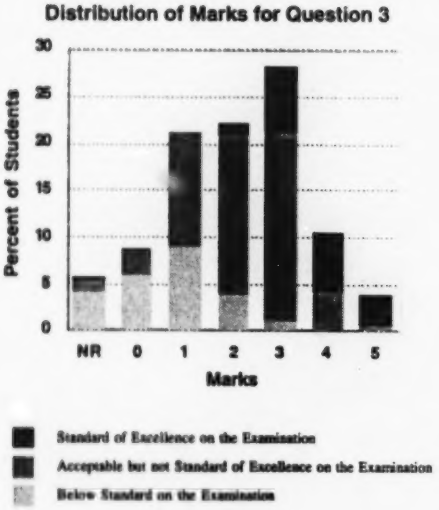
On this 5-mark question, the average mark was 3.45 or 69%.



Question 2 required students to determine the number of distinct quadratic equations, using all possible given values of A, C, D, and E in the context of the question. They were also asked to determine the probability that the graph produced is any conic centred at the origin and, from the given values of A, C, D, and E, explain which values could be used to generate an ellipse.

Students achieving the acceptable standard of achievement were expected to score 3 or more marks out of 5, and students achieving the standard of excellence were expected to score 4 or more marks out of 5. Of the students who achieved the acceptable standard of achievement on the examination, 61% scored 3 or more marks out of 5, and of the students who achieved the standard of excellence on the examination, 70.9% scored 4 or more marks out of 5.

On this 5-mark question, the average mark was 2.37 or 47.4%.



Question 3 required students to use the information provided in the question to determine the amplitude, period, and equation of a trigonometric function. Using the given contextual information, they were also asked to explain their predictions as to what effect global warming would have on the amplitude and vertical displacement of the given sinusoidal function.

Of the students who achieved the acceptable standard of achievement on the examination, 53.9% scored 3 or more marks out of 5, and of the students who achieved the standard of excellence on the examination, 52.4% scored 4 or more marks out of 5.

On this 5-mark question, the average mark was 2.11 or 42.2%.

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Scoring Guide for Written-Response Questions

Credit may be given to students who show unusual insight. If their solutions fall outside *Specific Question Scoring Rubrics*, they will be scored against the *General Scoring Guide* shown below.

GENERAL SCORING GUIDE

5 marks The student
- demonstrated a *complete understanding* of the problem
- used mathematical knowledge and problem-solving techniques to find the solution
- justified the solution and explained its relevance to the problem

4 marks The student
- demonstrated *an understanding* of the problem
- chose a strategy that used mathematical knowledge and problem-solving techniques to find a solution, but the procedure contained *a minor flaw*
- showed *some justification* of his or her results

3 marks The student
- demonstrated *some understanding* of the problem
- formulated *some aspects* of the problem mathematically
- demonstrated the use of a strategy that used mathematical knowledge and problem-solving techniques to find a *partial* solution
- communicated little understanding of the complexities of the problem

2 marks The student
- explored the *initial stages* of the problem
- applied *some* relevant mathematical knowledge and problem-solving techniques to find a *partial* solution

1 mark The student
- applied some relevant mathematical knowledge to the problem

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SPECIFIC QUESTION SCORING RUBRICS

Question 1

5 The student
- determines space required for three "nested" carts
- determines an expression for the length of n carts
- determines that there are 37 "nested" carts in 10.00 m
- determines the best shed design and communicates how this was determined

4 The student
- completes all bullets, but a minor error has occurred

OR

- completes two of the first three bullets **and** the fourth bullet, all correctly

3 The student
- completes the first three bullets correctly

OR

- completes the fourth bullet correctly

OR

- completes two of the first three bullets and attempts the fourth bullet, using relevant mathematical knowledge

2 The student
- completes one of the first three bullets correctly and attempts the fourth bullet, using relevant mathematical knowledge

OR

- correctly determines two of the first three bullets

1 The student
- correct answers any one of the first three bullets

OR

- applies some relevant mathematical knowledge to this problem

Question 2

5 The student
- determines that the number of distinct equations is 144
- determines the probability that the conic is centred at the origin is $\frac{1}{16}$
- explains which values for parameters A, C, D, and E are required to generate an ellipse

4 The student
- completes all bullets, but a minor error or omission has occurred

3 The student
- completes two of the three bullets correctly

OR

- completes one of the three bullets correctly and provides partial solutions to **both** the other bullets

2 The student
- completes one of the three bullets correctly

1 The student
- provides a relevant fact

e.g., 1 $AC > 0$
e.g., 2 states that $D = 0$ and $E = 0$ are to be centred at the origin
e.g., 3 realizes that his or her answer from the first bullet is the denominator for the probability fraction in the second bullet

Question 3

5 The student
- determines the amplitude, period, and the equation, and clearly explains the predicted effects of global warming on amplitude and vertical displacement

4 The student
- completes all bullets, but a minor error or omission has occurred

3 The student
- determines the amplitude, period, and the equation, but makes no predictions regarding global warming

OR

- determines the amplitude **or** period of f, **and** explains the predicted effects of Global Warming on amplitude and vertical displacement

OR

- determines the amplitude and period, and gives an explanation for global warming, with a minor omission

OR

- determines the amplitude or period, and gives a **complete** equation consistent with the amplitude and period provided, as well as an explanation for global warming, with a minor omission

2 The student
- determines the amplitude or period, and offers a partial solution for the other parts of the problem

OR

- explores the initial stages of the first two parts of the problem, and provides two correct predictions for global warming

OR

- has a correct equation

OR

- has a complete explanation for global warming

1 The student
- determines a reasonable value for one parameter, or has a partially correct equation

OR

- makes a meaningful comment regarding the predicted effects of global warming on future graphs

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For further information, contact Marion Florence (mflorence@edc.gov.ab.ca) or Phill Campbell (pcampbell@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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